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Nó. 6. SAN FRANCISCO, CALIFORNIA, JANUARY 25, 1890.

NOTE ON THE DENSITIES OF THE PLANETS.

BY DANIEL KIRKWOOD, LL.D.

The major planets *Jupiter*, *Saturn*, *Uranus* and *Neptune*, as well as the sun, have gaseous envelopes of unknown depth. We know little or nothing as to the physical constitution of the asteroids and telescopic satellites. There remain the five bodies, *Mercury*, *Venus*, the *Earth*, the *Moon* and *Mars*. Of the last three the masses, volumes and densities have been determined. *Venus* is less accurately known, and considerable uncertainty still attaches to the mass of *Mercury*. The recent researches of Professor HARKNESS* have suggested the inquiry whether any discoverable order obtains between the relative densities of these five bodies. For the purpose of comparison, let us arrange them in the order of their diameters, with the relative masses and densities resulting from the investigations of HARKNESS:

PLANETS INTERIOR TO THE ZONE OF ASTEROIDS.

NAME.	MEAN DIAM.	MASS.	MEAN DENSITY.
The Earth	1.000	1.0000	1.000
Venus.....	0.972	0.8220	0.895
Mars	0.534	0.1076	0.707
Mercury.....	0.382	0.0382	0.683
The Moon	0.273	0.0123	0.610

Adopting the masses obtained by HARKNESS, it follows:

1. That the *Earth* is the most dense of all the planets; and
2. That in every instance a greater mass corresponds, not only to a greater diameter, but also to a greater density. An approximate

* GOULD'S *Astr. Journ.*, No. 194.

form of the relation might be given, but the new value of *Mercury's* mass requires confirmation.

ARLINGTON AVENUE, RIVERSIDE, CAL., November, 1889.

N. B.—This note was already in type when the author learned from the *Sidereal Messenger* for December, 1889, (p. 471), that a note on the same subject had been printed in the *American Journal of Science* for November last. It was, however, too late to withdraw the article.

A NEW AND SIMPLE FORM OF ELECTRIC CONTROL FOR EQUATORIAL DRIVING-CLOCKS.

BY JAMES E. KEELER.

It is well known that the driving-clocks of equatorial telescopes, which demand a continuous motion, cannot be made to run with the uniform rate which is characteristic of a good pendulum clock; hence, methods are sought for regulating a continuous motion by means of a pendulum. Devices for effecting this mechanically have not been successful, where great accuracy is required. In such arrangements extra work is necessarily thrown upon the pendulum, which is prevented from swinging freely, and is then no longer isochronous. By means of electricity, however, the control can be effected without detrimental reaction on the pendulum.

For a description of the ingenious devices which have been invented for controlling driving-clocks electrically, the reader is referred to a pamphlet by Sir HOWARD GRUBB,* describing four different systems which have been tried or are actually in use.

The driving-clock of the 36-inch equatorial of the Lick Observatory is of the same form as the smaller driving-clocks by WARNER & SWASEY, with a few modifications, made necessary by its unusual size and weight. The governor-balls weigh sixty pounds each, and their centers of figure and gravity are not coincident; so that the regulation for rate may be effected by turning the balls on their axes. The vertical shaft of the governor rotates once a second. One of the clock-arbors, which rotates in one minute, has been converted into a chonograph by the makers, an extremely convenient arrangement, since it gives a means of studying the performance of the machinery by an astronomical clock, without direct reference to the heavens.

* On the Latest Improvements in the Clock-driving Apparatus of Astronomical Telescopes. By Sir HOWARD GRUBB, Inst. of Mech. Eng., London, 1888.